A Dissertation on

COMPARATIVE STUDY OF FUNCTIONAL OUTCOME OF SUPRACONDYLAR FRACTURES OF FEMUR TREATED WITH DISTAL FEMUR LOCKING COMPRESSION PLATE WITH THAT OF SUPRACONDYLAR NAIL

Submitted in partial fulfilment of

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CERTIFICATE

This is to certify that this dissertation entitled "**COMPARATIVE STUDY OF FUNCTIONAL OUTCOME OF SUPRACONDYLAR FRACTURES OF FEMUR TREATED WITH DISTAL FEMUR LOCKING COMPRESSION PLATE WITH THAT OF SUPRACONDYLAR NAIL**" submitted by Dr.Krishna Kumar M.S., to the faculty of ORTHOPAEDICS, The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfilment of the requirement in the award of degree of M.S. Degree, (ORTHOPAEDICS), for the April 2011 examination is a bonafide research work carried out by him under our direct supervision and guidance.

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This is to certify that the INSTITUTIONAL ETHICAL COMMITTEE of TIRUNELVELI MEDICAL COLLEGE AND HOSPITAL, TIRUNELVELI-11 has unanimously approved the dissertation titled COMPARATIVE STUDY OF THE FUNCTIONAL OUTCOME OF SUPRACONDYLAR FRACTURES OF FEMUR TREATED WITH LOCKING PLATE WITH THAT OF SUPRACONDYLAR NAIL. by DR.KRISHNAKUMAR, M.S., (ORTHO) II YEAR student, TIRUNELVELI MEDICAL COLLEGE, TIRUNELVELI-11 in its meeting held on 09.10.2009.

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To
The Concerned.

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DECLARATION

I, Dr. KRISHNA KUMAR M.S Solemnly declare that this dissertation titled "**COMPARATIVE STUDY OF FUNCTIONAL OUTCOME OF SUPRACONDYLAR FRACTURES OF FEMUR TREATED WITH DISTAL FEMUR LOCKING COMPRESSION PLATE WITH THAT OF SUPRACONDYLAR NAIL**" is a bonafide record work done by me in the Department of Orthopaedics, Tirunelveli Medical College and Hospitals, Tirunelveli under the guidance of **Prof. Dr.Ramakrishnan M.S. Ortho, D'Ortho** Prof. & Head of the Department of Orthopaedics, Tirunelveli Medical College and Hospital, Tirunelveli.

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INTRODUCTION

Supracondylar and Intercondylar fractures of distal femur historically have been difficult to treat. These fractures often are unstable and comminuted and occur in elderly or multiply injured patients. The incidence is higher in women older than 75 years and in adolescent boys and men 15 to 24 years old.

Non operative treatment were often encountered with difficulties including persistent rotatory and angulatory deformity, knee joint incongruity, loss of knee motion, delayed mobilization and secondary OA.[1,2,3,4.]

During the last few decades most surgeons have favoured internal fixation. Better understanding of the injury pattern, availability of better implants, the concept of early surgical fixation and early post operative knee mobilization all have improved the functional outcome of the patient as whole. [5,6,7,8,9,10,11,12.]

The goals of surgical treatment are anatomic reduction of the articular surface, restoration of limb alignment, length and rotation and stable fixation that allows for early mobilizations and minimal soft tissue damage to prevent post operative contractures and adhesions.

The various reasons for difficulty in fixation are thin cortices, wide medullary cavity, relative osteopenia, fracture comminution, intra articular extension and injury to quadriceps mechanism.

The successful management of supracondylar fractures demands familiarity with the anatomy and classification, technical aspects of fracture fixation and the art of post operative management.

HISTORICAL REVIEW

During the past two decades, the management of Supracondylar fracture has advanced greatly. In the 1930's Mahorner and Bradburn reported unsatisfactory results with Russel traction. In 1945 Funsten and Lee observed that fracture of distal 1/3 healed sooner than middle or proximal third. In 1951 Delorome and West suggested fibrosis after trauma as the prime cause of knee stiffness. In 1950s Watson and Jones, White and Russin and Sir John Charnley recommended non-operative treatment.

Surgical treatment started in 1960's met with lot of failure. In 1965 Muller suggested L shaped compression plate. Rush in 1968, used straight intramedullary rods. Vessely DG in 1968 used single or double split diamond nail by bifurcating the distal end. In late 60's Neer's classification came into vogue. Seeing multiple failure with surgery, Mooney in 1970 advised cast brace traction.

The AO group were the one to popularize surgery in early 1970's Statis in 1971 was the first to use condylar blade plate. Brown and Benum also reported good results. In 1974 Shatzker reported good results with operative methods. In 1971 Robert Zickel designed Zickel Nail. In 1979, Zimmerman used DHS for distal femur fractures.

In 1983 Kolmert introduced semi-elastic devices consisting of intramedullary elastic nails. In 1986 Regazzoni, Reudi and Allgower used DCS for distal femur for the first time and reported excellent results. In 1990 AO modified Muller's classification, In 1991, Green, Seligson and Henry introduced supracondylar GSH Nail.

ANATOMY

The supracondylar area of the femur is defined as the zone between the femoral condyles and the junction of the metaphysis and the femoral diaphysis. This comprises approximately the distal 15cm of the femur, as measured from articular surface.

The femoral shaft is nearly cylindrical, but at the lower end it broadens into two curved condyles. If viewed on end, the shape of the distal femur is trapezoidal (narrower anteriorly than posteriorly) with an angle of inclination of medial surface of about 25 degrees. Anteriorly the two condyles come together to form a joint for articulation of patella. Posteriorly, they are separated by a deep groove, the intercondylar fossa that gives attachment to the cruciate ligaments of the knee.

The contact surface of the Patella includes parts of both condyles, but is derived predominantly from the lateral condyle. The lateral condyle is broader and extends farther promimally. The lateral epicondyle arises from the lateral condylar surface, giving rise to fibular collateral ligament. Immediately below the lateral epicondyle is an oblique groove that houses the popliteus tendon.

The medial condyle is longer than the lateral condyle and extends farther distally. Its medial surface is convex and contains an epicondyle that gives attachment to the tibial collateral ligament. Situated on the proximal most part of the condyle is the adductor tubercle, into which the adductor magnus muscle inserts.

BIOMECHANICS

The expanded femoral and corresponding tibial condyles are adapted for the direct forward transmission of weight. During weight bearing, the two condyles rest on the horizontal plane of the tibial condyles and the shaft of femur inclines inferomedially. This inclination is an expression of the greater width of the body at the hips than the knees.

The longitudinal axis of the diaphysis of the femur inclines medially downwards, with an angle of 8^0 from vertical. The mechanical axis of femur formed by a line between centre of hip and knee joint is 3^0 from vertical.

In the sagital plane, the femoral condyles have a changing radius which decreases from before backwards. In the transverse plane the condyles diverge from before backwards by an angle of 20^0.

The axis at which flexion and extension occur shifts backwards in relation to the tibia with increasing flexion. However, it lies approximately along the line joining the femoral epicondyles.

The knee joint possess features of both hinge and pivot joint. The joint permits flexion and extension in sagital plane and some degree of rotations when the joint is flexed. The complex flexion extension motion is a combination of Rocking and Gliding.

The natural deflection outward of tibia on femur at the knee joint produces greater weight bearing stresses on the lateral femoral condyle, but because the medial condyle is prolonged farther forward than the lateral condyle, the vertical axis of rotation falls in a plane near the medial condyle.

The medial and lateral condyle have different configuration. The lateral condyle is broader in the anteroposterior and transverse planes than the medial condyle, and the medial condyle projects distally to a level slightly lower than the lateral condyle. This distal projection helps to compensate for the inclination of mechanical axis in erect position. The articular surface of medial condyle is prolonged anteriorly and as the knee comes into full extension, the femur internally rotates until the remaining articular surface on the medial condyle is in contact. The posterior portion of lateral condyle rotates forwards laterally, thus producing screwing home movement, locking the knee in full extension.

The distal femur when viewed in cross section, the shape resembles a trapezoid with the medial side inclined about 25^0 and the lateral side about 10^0.

When the distal femur is viewed from the side, the condyles appear to have been added posteriorly to the shaft. Therefore for the purpose of internal fixation, any device must be inserted into the middle of the anterior half of the condyles.

COMMON SURGICAL APPROACH

Lateral Approach

A direct lateral approach is most commonly used exposure for open reduction and plating of distal femur. Patient is positioned supine with a bump beneath the ipsilateral hip to internally rotate the leg. The skin incision is longitudinal and distally is centered over the lateral epicondyle. The fascia lata is incised along its fibers exposing vastus lateralis which is reflected off the lateral intermuscular septum.

Visualization of the articular surface of lateral condyle is adequate, but exposure of intercondylar notch and medial condyle is limited. Occasionally a tibial tubercle osteotomy can be performed to allow for reflection of extensor mechanism and wide articular exposure[13].

If wider exposure of the distal femur is planned for repair of intercondylar fractures (type C), the use of lateral parapatellar arthrotomy is advisable[14]. This provides adequate access to the articular surfaces, and can be extended proximally into the quadriceps mechanism as an extensile antero lateral approach to include the femoral shaft.

Approach for Retrograde intramedullary femoral nailing

Intramedullary nailing is usually performed through a medial parapatellar incision, but if an intra-articular split or more complex articular injury is present, an open medial or lateral arthrotomy can be performed for reduction and stabilization of the femoral condyles prior to nail insertion.

CLASSIFICATION

There is no universally accepted method of classification for supracondylar fractures of femur. Essentially all classifications distinguish among extra articular, intra articular and isolated condylar lesions. Unfortunately, anatomic fracture classifications fail to address the conditions commonly associated with supracondylar fractures, which influence treatment or outcome. These factors which play a dynamic role in management, determine the personality of the fracture. Among these are

a) Amount of fracture displacement
b) Degree of comminution
c) Extent of soft tissue injury
d) Associated neurovascular injuries
e) Magnitude of joint involvement
f) Degree of osteoporosis
g) Presence of multiple trauma
h) Complex ipsilateral injuries.

Various classifications used for distal femur include Neer's classification, Stewart's classification, Schatzker's classification, Seinsheimer's classification, Muller's classification and AO classification.

Muller's classification is the most widely accepted classification of supracondylar fractures and has been adopted and modified by the AO group.

NEER'S CLASSIFICATION

Type – I	-	non displaced or minimally displaced fractures.
Type – II	-	displaced fractures
II (A)	-	medial displacement of condyles
II (B)	-	lateral displacement of condyles
Type – III	-	conjoined supracondylar and intercondylar fracture

MULLER'S CLASSIFICATION

A - femur distal, extra articular fracture

A1 - simple

A2 - metaphyseal wedge

A3 - metaphyseal complex

B - femur distal condylar, partial articular fracture

B1 - lateral condyle fracture, saggittal

B2 - medial condyle fracture, saggittal

B3 - in frontal plane (Hoffa's fracture)

C - femur distal, complete articular fracture

C1 - articular simple, metaphyseal simple T or Y shaped fracture

C2 - articular simple metaphyseal multifragmentary with 2 principle articular fragments

C3 - both articular and metaphyseal multifragmentary (intrarticular comminution)

AO Classification of fracture of the femur (Distal Fragment)

Type A extra articular fractures

A1 - simple fracture

1.1 - avulsion fracture of medial or lateral epicondyle

1.2 - fractures of metaphysis, oblique or spiral

1.3 - fractures of metaphysis, transverse

A2 - metaphyseal wedge fractures

2.1 - wedge intact.

2.2 - lateral multifragmentary wedge

2.3 - medial multifragmentary wedge

A3 - complex metaphyseal fracture

3.1 - with split intermediate segment

3.2 - irregular, limited to metaphysis

3.3 - irregular, extending into diaphysis

Type B - fractures are partial articular

B1 - lateral condylar fracture in saggital plane

1.1 - simple through intercondylar notch

1.2 - simple through weight bearing surface.

1.3 - multifragmentary

B2 - medial condylar fractures in saggital plane

2.1 - simple through the intercondylar notch

2.2 - simple though weight bearing surface

2.3 - multifragmentary

B3 - frontal plane fracture

3.1 - flake fracture anterior & lateral

3.2 - posterior unicondylar

3.3 - posterior bicondylar

Type C - fractures are complete articular

C1 - simple fracture of both articular surfaces & metaphysis

1.1 - slightly displaced T or Y fracture

1.2 - markedly displaced T or Y fracture

1.3 - distally situated T fracture with the horizontal element involving diaphysis

C2 - simple fractures of articular surface multifragmentary of metaphysis

2.1 - with intact wedge

2.2 - multrifragmentary wedge

2.3 - complex

C3 - multifragmentary of both metaphysis and articular surface

3.1 - metaphyseal wedge with multifragmentary articular

3.2 - multifragmentary metaphysis with multifragmentary articular

3.3 - multifragmentary articular and metaphysis extending into the shaft

MECHANISM OF INJURY

The mechanism of injury in most supracondylar fractures is thought to be axial loading with varus, valgus or rotational forces. A bimodal distribution of high energy injuries in young patients and low energy injury in elderly patients is typically seen. In younger individuals, these fractures typically occur after high energy motor vehicle accidents. In these patients there maybe considerable fracture displacement, comminution, open wounds and associated injuries. On the other hand, in elderly osteoporotic patients, fractures frequently occur after a minor slip and fall on a flexed knee, leading to fragility fracture through compromised bone. Notching of anterior cortex of the distal femur while making femoral chamfer cuts during knee arthroplasty may predispose the distal femur to fracture.

The deformities that occur after a distal femur fracture are produced primarily by the direction of the initial fracture displacement and secondarily by the pull of muscles. Spasm and irritability in the quadriceps and hamstrings often lead to limb shortening with varus angulation at the fracture site as a result of strong pull of adductor muscles.

Contraction of gastrocnemius often produces apex posterior angulation and displacement of distal fragment. In fracture with intercondylar extension, soft tissue attachments to the respective condyles tend to produce splaying and rotational malalignment of condyles. These are the forces the fracture reduction and the stabilizing implants must overcome and resist if an anatomic outcome is to be achieved.

INVESTIGATIONS

Clinically the patient may present with symptoms and signs of supracondylar fractures or with other injuries and may be in shock.

All patients with fracture lower end of femur should be examined for peripheral pulses.

A good quality AP and lateral radiograph of the knee and distal femur are often sufficient. X-rays of the pelvis, ipsilateral hip and femoral shaft are necessary to rule out associated injuries.

Traction radiograph are helpful if there is significant shortening and deformity and provide better understanding of the fracture morphology.

CT scans with axial, coronal and sagital reconstruction of the distal femur are an important adjunct to plain radiograph. Intra articular injuries are better delineated and a number of potentially important occult fractures identified. Mork et al[14] showed a 40% rate of coronal plane or Hoffas fractures with intercondylar fractures, many of which are missed with plain radiograph alone[15].

If there is doubt regarding vascular injury a doppler ultrasound study can be done. But it cannot rule out intimal tear.

Indications for arteriography

a) absent or diminished pulses

b) expanding hematoma

c) arterial bruit

d) progressive swelling

e) persistent arterial bleeding

PRINCIPLES OF MANAGEMENT

The pattern of the fracture determines the management. They include

a) Amount of fracture displacement

b) Degree of comminution

c) Extent of soft tissue injury

d) Associated neurovascular injuries

e) Magnitude of joint involvement

f) Degree of osteoporosis

g) Presence of multiple trauma

h) Complex ipsilateral fractures (eg. patella, tibial plateau fractures)

THE OBJECTIVE OF TREATMENT OF LOWER END OF FEMUR FRACTURES ARE

1) to obtain and maintain satisfactory reduction and rigid fixation

2) to regain normal quadriceps strength

3) to regain a functional range of knee motion

4) early mobilization / ambulation

5) to treat associated injuries

METHODS OF TREATMENT

In the decade of 1960's, non-operative treatment methods such as traction and cast bracing produced better results than operative treatment, because of the lack of adequate internal fixation devices.

The blade plate designed by the AO group was one of the first used implants and gained wide acceptance for treatment of distal femoral fractures. As it was technically demanding, a less technically demanding Dynamic Condylar Screw was introduced. Those fractures for which both DCS & blade plate could not used were fixed with Condylar buttress plate. More recently locking condylar buttress plates are being used which are superior especially in osteoporotic patients.

Intramedullary nailing has recently gained increasing popularity due to its biological fixation. Nails have been designed that can be inserted retrogradely through the intercondylar notch for the supracondylar and intercondylar fractures.

External fixators and Ilizarov fixators are used for temporary or definitive fixation. They play a major role in open fractures and those associated with vascular injuries.

So management of distal femoral fractures are

1. non operative treatment
2. operative treatment

Operative treatment maybe

1. ORIF with DCS
2. ORIF with condylar blade plate
3. ORIF with condylar buttress plate
4. ORIF with cancellous screw
5. ORIF with locking compression plate
6. Closed reduction and internal fixation with antegrade locking nails
7. Closed reduction and internal fixation with supracondylar nails
8. Ilizarov method
9. External fixator

CONSERVATIVE MANAGEMENT

Non operative treatment is reserved for patients with non displaced fractures and those who are not candidates for surgery because of comorbidities. This method requires confinement to bed, is time consuming and expensive and is not well suited for multiply injured or elderly[16,17,18,19].

RELATIVE INDICATIONS FOR CONSERVATIVE TREATMENT

1) Undisplaced or incomplete fractures
2) Non ambulatory patient (eg. paraplegia)
3) Significant underlying medical diseases
4) Imminent death
5) Lack of modern fixation devices

The goal of conservative treatment is not anatomical reduction but maintenance of overall length and axial alignment.

THE CRITERIAS FOR ACCEPTABLE FRACTURE REDUCTION IN CONSERVATIVE TREATMENT

1) less than 7^0 angulation in frontal plane
2) less than $7^0 – 10^0$ angulation in sagital plane
3) limb shortening less than 1.5 cm
4) articular incongruity less than 2 cm

The methods of conservative treatment are

a) two pin method of skeletal traction (one lower femoral and one upper tibial)

b) skeletal traction with single pin followed by cast

c) ambulatory cast brace

d) fracture brace technique

Complications of conservative treatment are

1) deep vein thrombosis

2) pulmonary embolus

3) decubitus ulcers

4) pneumonia

5) urinary tract infections

SURGICAL TREATMENT

In the past 30 years, internal fixation of displaced fractures of lower end femur has gained widespread acceptance as operative technique and implants have improved. The combinations of properly designed implants, a better understanding of soft tissue handling, preoperative antibiotics and improved anesthetic methods have made internal fixation safe and practical. Since, 1970 all studies comparing the results of non-operative and operative methods have favoured operative stabilization of supracondylar fractures[20].

THE GOALS OF OPERATIVE TREATMENT OF SUPRACONDYLAR FEMORAL FRACTURES ARE

a) Anatomical alignment

b) Stable internal fixation

c) Early mobilization

d) Functional rehabilitation of knee

INDICATIONS FOR OPERATIVE MANAGEMENT INCLUDE

1) displaced intra articular fracture
2) patients with multiple injuries
3) open fractures
4) associated vascular injuries requiring repair
5) associated ipsilateral limb injuries (eg. patella, tibial plateau)
6) major associated knee ligamentous injuries
7) irreducible fractures

8) pathological fractures

9) fractures around total knee arthroplasty

Contra indications for internal fixation include

a) active infection

b) contaminated open fractures (type III-B)

c) massive comminution or bone loss

d) severe osteopenia

e) inadequate facilities

f) inexperienced surgeon

Sequence in surgical management of supracondylar fractures are

1) restoration of articular surface

2) stable internal fixation

3) bone grafting of metaphyseal comminution

4) impaction of fracture in osteoporotic patients

5) repair of associated ligamentous injuries

6) early knee mobilization

7) protected weight bearing

IMPLANTS

1) 95º CONDYLAR BLADE PLATE (CBP)

It is the first implant used for supracondylar fractures. When used by experienced surgeon, this restores alignment and provides stable internal fixation. Because it is a one piece device, it affords the best control of fractures. However placing of 95^0 CBP is technically demanding procedure, leaving little room for error. It can be used for intercondylar fractures provided the lateral cortex is not comminuted. The main advantage of CBP is its increased stable fixation. In the distal femur the blade plate has to be inserted so that it will be in line with axis of the shaft, and with joint axis and with the inclination of patellofemoral joint and be inserted exactly in the middle of anterior half of the femoral condyle at a predetermined distance from the joint and has to line up with the femoral shaft.

Initially the 130^0 plate was used for the distal femur also. With time it became evident that the 95^0 plate was physiological one. So CBP has a fixed angle of 95^0 between its blade and plate. It comes in varying diameter. The length to be used vary with fracture pattern.

2) DYNAMIC CONDYLAR SCREWS (DCS)

This is a less technically demanding alternative to CBP. While the blade requires accurate insertion in three planes simultaneously, the DCS allows freedom of fixation in flexion and extension plane. A minimum of 4cm of uncomminutted bone in the femoral condyle above the intercondylar

notch is necessary for successful fixation. The main disadvantage is that the insertion requires removal of large amount of bone which makes revision surgery, should it be necessary, more difficult. Other advantages include its ability to apply interfragmentary compression across femoral condyles, better purchase in osteoporotic bone. One technical disadvantage is that its shoulder is more prominent than that of the angled plate, hence it cause knee symptoms. Such as iliotibial band sliding over the prominent edge of the implant, producing severe irritation. In low supracondylar fractures , the condylar screw may not provide as much rotational control of the distal fragment as that of 95^0 CBP.

3) CONDYLAR LOCKING PLATE

Blade plate and condylar screws are unsuitable for use in fractures with less than 3 – 4 cm of intact femoral condylar bone and in fractures with a large amount of articular comminution. For these fractures, the condylar buttress locking plate is the most commonly used implant. It is a one piece device specifically designed for the lateral distal femur. It is essentially like a broad DCP with a clover leaf shaped distal portion designed to accommodate upto six cancellous screws. Because the posterior portion of the clover leaf is larger than anterior, it is manufactured separately for left and right sides. The plate holes have a threaded surface which corresponds to the threaded under surface on the head of the screw, hence the screw gets locked into the plate and forms fixed angled device construct.

The locking plate has the following advantages

a) the screws are locked to the plate and hence provide superior fixation in osteoporotic and comminuted fractures
b) they can be combined with minimally invasive technique for insertion
c) the screw loosening and screw breakages at the plate screw junction is reduced.
d) can be used as bridge plate

4) REAMED INTRA MEDULLARY NAILING

Intra medullary nailing has received increased attention for the treatment of distal femoral fractures recently. These devices obtain more biological fixation than plates because they are load sharing. They offer greater soft tissue preservation. Perhaps the most common application for an antegrade nail is the fracture of distal third femur with supracondylar extension. The major disadvantage of nail fixation is that they are less rigid, especially due to the wide medullary cavity of distal femur.

5) SUPRACONDYLAR NAIL

Recently nails have been designed specifically for retrograde insertion through intercondylar notch. It was developed by Green, Seligson and Henry and hence called GSH nail. It is a cannulated closed section stainless steel device. It has an 8^0 apex anterior bend near the distal end to accommodate, the geometry of femoral condyles. The most unique feature

of the GSH nail is its intraarticular starting point, which allows it to be used for very distal fractures. Closed placement with indirect reduction of the fracture minimizes soft tissue and periosteal damage, thus preserving vascularity. Less surgical dissection is required resulting in less blood loss, less muscle damage and less postoperative discomfort. Distal femoral fractures with hip implants or with total knee replacement with an open notch design also can be effectively treated with retrograde nails. It can also be used in cases of floating knees, for simultaneous fixation of tibial and femoral fractures, through the same incision. The design of the retrograde supracondylar nail is associated with potential disadvantages as well. The intra articular portion will lead to knee stiffness, patello-femoral degeneration and synovial metallosis. The proximal tip of the nail generally lies in the mid or distal femoral shaft, creating a stress raiser[21].

6) FLEXIBLE AND SEMI RIGID NAILS

In 1970 Zickel developed a nail specifically for use in distal femur, the nail has a flexible stem and a rigid curved condylar end allowing it to be anchored by fixation screws into femoral condyles.

Closed Rush pinning was also used for treatment of supracondylar fractures. But it was associated with complications like pin migration, knee irritation, loss of reduction and malunion.

7) ILLIZAROV FIXATION

It has a minimal role in fixation of supracondylar fractures. The few indications are

a. Intra articular fractures

- fracture dislocation
- condylar fractures

b. Severly comminuted fracture

- unstable type
- with bone loss

c. Compound fractures

Disadvantages with Illizarov method are

- reduced patient compliance
- pin tract infection
- pin loosening
- malunion

POST OPERATIVE MANAGEMENT

Post operative rehabilitation depends upon the stability of the fixation and the fracture pattern and must be individualized for each patient. Antibiotic therapy is given according to the nature of injury. If the fixation is stable, the patient can be started on knee mobilization on CPM exercises from 24 – 48 hours after surgery. Hinged knee braces are used to protect fracture site. Isometric muscle strengthening exercises and limited active assisted knee range of motion is encouraged. Initially touch down weight bearing is allowed and is progressed as callus formation increases over next 4-6 weeks. Full weight bearing is allowed after clinical and radiological union.

In patient with less stable fixation, initial casting is necessary, which is followed by functional brace. In these cases full weight bearing must be delayed until radiological evidence of fracture healing.

IMPLANT PROFILE

DYNAMIC CONDYLAR SCREWS (DCS)

Design features

The DCS implant system is composed of DCS lag screw and a barrel plate. DCS plates have a barrel angle 95^0. A wide selection of plate lengths (from 4 holes to 16 holes) are available.

Profile of barrel plate

Thickness - 5.4mm

Width - 16mm

Hole spacing - 16mm

Barrel length - 25mm

Lag screw - 50mm – 140 mm (in 5mm increments)

Profile of DCS screw

Thread diameter - 12.5mm

Thread length - 22mm

Shaft diameter - 8mm

In addition there is compression screw which is driven home in the lag screw after the fixation of barrel plate to the lateral cortex.

The strength superiority of DCS implant is mainly due to its cross sectional area. It is capable of with standing much higher load than condylar blade plate.

CONDYLAR BLADE PLATE SYSTEM

Condylar blade plate has a fixed angle of 95^0 between its plate and blade portion. The shortest plate available has 5 holes. The shortest blade is 50mm. Before an angled plate can be inserted in a bone, a channel must be drilled or precut with U profile seating chisel. The seating chisel guide is used to determine the rotation of seating chisel about its long axis.

Profile of 95° condylar plate

Thickness	-	5.6mm
Width	-	16mm
Hole spacing	-	16mm
U profile blade	-	6.5 x 16 mm

SUPRACONDYLAR NAIL

The standard, supracondylar nails are fully cannulated, closed section, stainless steel nail. They are provided with insertion jig for proximal locking.

Nail profile

Length	-	15cm, 20cm, 25cm
Diameter	-	11mm, 12mm, 13mm
Anterior bend	-	8°

Locking screw profile

Diameter	-	5mm. 6.5mm (canulated)
Length	-	25mm to 90mm

LOCKING PLATE

The LCP distal femur plates are based on the LCP system. The shaft portion of the plate features Combi hole and the head features threaded holes. The shape of the plate is based on the design of the distal femur LISS plate. The plates are available in 5, 7, 9, 11 and 13 holes for both left and right femur.

Threaded holes in plate head: Round locking holes accept 5.0mm locking screw and 4.5mm cortex screw.

Pre shaped plate : The pre shaped low profile plate reduces soft tissue damage and eliminates need for contouring.

LCP Combi holes in shaft: The Combi hole allows an internal fixation using standard 4.5mm cortex screw, 5.0mm locking screw, or a combination of both, thus allowing more flexible intraoperative technique.

COMPLICATIONS

Although the use of biological approaches and state of the art implants have improved results, their use does not guarantee a favourable outcome.

Complications of fracture

1) infection
2) vascular injuries
3) nerve injuries
4) non union
5) mal union
6) pulmonary complications
7) missed associated fractures
8) knee stiffness

Complications of operative treatment

1) incomplete reduction
2) incongruent reduction
3) unstable fixation
4) wrong size of implant
5) loss of knee motion
6) infection

INFECTION

One of the major drawbacks with operative treatment of supracondylar femur fracture is the risk of infection. The average rate of infection is between 3 – 5%. If deep infection develops post operatively, aggressive irrigation and wound debridement are indicated. Types specific antibiotics are given intravenously for 3-6 weeks. The duration of antibiotics should be correlated clinically and with laboratory investigations and bacteriological studies. In the presence of infection, implants that provides stability should be retained. Nonetheless, if implant is loose, it should be removed and the fracture temporarily stabilized with external fixator. The role of antibiotic impregnated beads and Ilizarov fixator remains controversial.

NON UNION

Non Union is more common with conservatively treated cases than in cases treated surgically. Non union is generally due to the presence of infection, unstable fixation, mechanical failure of the implant or any combination of these. Treatment of non union may be difficult owing to preexisting or disuse osteopenia, proximity to the knee joint and prior surgical procedures. Aseptic non union in patients with reasonable bone stock should be treated with repeat osteosynthesis with bone grafting. Hypertrophic non unions usually respond to stable internal fixation. In patients with atrophic non union or bone loss, supplemental autologous bone grafting or bone morphogenic protein is often required. In rare instances

methylmethaacrylate or tricalcium phosphate cements can be used to augment screw fixation.

POST TRAUMATIC ARTHRITIS

The incidence of post traumatic arthritis is unknown. Nonetheless, incongruity of the joint surface is the leading cause of early arthritis. In patients with unicompartmental arthritis, a corrective osteotomy may be appropriate. In patients with severe disabling bicompartmental or tricompartmental arthritis, a total knee replacement may be indicated. Factors such as age, range of knee motion, presence or absence of flexion contracture and infection plays a major role in surgical decision making.

KNEE STIFFNESS

The most common complication following distal femur fracture is loss of knee motion. This untoward complication invariably results from damage to the quadriceps mechanism and joint surface, as a result of initial trauma or surgical exposure or both. Quadriceps scarring with or without arthrofibrosis of the knee or patellofemoral joint is thought to restrict joint movement. The effects are greatly magnified by immobilization after fracture or internal fixation. Immobilization of the knee for more than three weeks usually results in some permanent stiffness.

Early stable internal fixation with meticulous soft tissue handling and immediate mobilization of knee joint maximizes chances of optimal outcome. Forceful manipulation of knee should be avoided. One approach

is arthroscopic release of adhesions with gentle manipulation under anesthesia.

MALUNION

Malalignment of greater than 5 – 10 degrees is likely to effect knee mechanics and gait. Increased varus and valgus, may lead to over loading of the joint and subsequent arthrosis of the medial or lateral compartment respectively.

VASCULAR COMPLICATIONS

The treatment of arterial injuries in conjunction with supracondylar fracture depends on severity of ischemia and amount of time elapsed since injury. If distal pulse is present the fracture should be fixed first. If arterial compromise is severe or the time elapsed is more than 6 hours, reestablishment of circulation takes priority. This can be done by temporarily shunting the flow or by direct repair with interposition vein graft or synthetic graft. One of the common mistakes is to repair the vessel with displaced fracture insitu. During subsequent fixation, manipulation of overriding fracture fragments can disrupt anastomosis.

PULMONARY COMPLICATIONS

When stabilization of fracture was delayed in patients with multiple injuries, pulmonary complications were higher. Patients with poly trauma had 22% of fat embolism.

ASSOCIATED LIGAMENTOUS INJURIES

Concomitant ligamentous injuries to the knee are uncommon and are rarely diagnosed preoperatively. The most commonly injured ligament is Anterior Cruciate Ligament (ACL). Initially non operative treatment is recommended as repair or reconstruction may produce further comminution, prolong operating time and increase risk of loss of motion and infection. Later reconstruction should be done after fracture healing.

EVALUATION OF OUTCOME

There are a lot of rating systems for evaluation of outcome. We followed the rating system of Neer. Other systems like the hospital total knee care system and Schatzker system are more complicated to follow.

Neer rating system

Character	Score	Definition
Pain	4	No pain in all ranges of motion
	3	Pain with normal daily activity
	2	Minimal activity gives pain
	1	Pain at rest
Movements (in degrees)	4	Flexion >= 120: No FFD
	3	Full Extension, flexion 90 to 120
	2	Loss of Extension less than 10; Flexion 70^0 to 90^0
	1	Flexion < 60
Function	4	Full weight bearing, Normal gait No functional impairment
	3	Limp, No restriction of activity
	2	Requires walking aid
	1	Cannot walk

Shortening (cm)	4 3 2 1	0 - 0.5 cm 0.5 - 2.5 cm 2.5 – 5 cm > 5 cm
Angulation (degree)	4 3 2 1	None <10^0 10^0 – 15^0 > 15^0

Result	Score
Excellent	16-20
Good	12-16
Fair	8-12
Failure	4-8

Rating	Motion	Angulation	Pain	Shortening	Functional ability
Excellent	Full extension Flexion 90^0 - 120^0	None	None	None	Full Weight bearing
Good	Full extension	$<10^0$	Pain with normal activity	< 2.5 cm	Limping no restriction
Fair	Loss of extension less than 10^0 Flexion 70^0 - 90^0	10^0 - 15^0	Pain even with Minimal activity	2.5 – 5 cm	Requires walking aid
Failure	Flexion < 60^0	> 15^0	Pain at rest	> 5 cm	Cannot walk

PREAMBLE

Supracondylar fractures with intercondylar extension may be considered as an enigma in orthopaedics. Complex anatomical features, nature of injury, associated complications, technical difficulties in using the implants, cost factors, availability of implants and patients general conditions all have bearing on early surgical management of these fractures.

This series includes 20 cases of supracondylar fractures with intercondylar extension (Muller type C), all in adults and all of whom underwent internal fixation with either DISTAL FEMUR LOCKING COMPRESSION PLATE or SUPRACONDYLAR NAIL.

Based on our findings we here by submit "comparative study of functional outcome of supracondylar fractures of femur treated with distal femur locking compression plate with that of supracondylar nail".

AIM OF STUDY

Often in a rush to save patient's life the fractures are ignored to the bottom of priority list, to be treated only if the patient survives. But a definitive fracture care even during resuscitation as a part of it, has markedly improved the functional out come.

The fear of infection, the presence of systemic, other traumatic factors, the concept of giving priority to some other fractures in a polytrauma patient have all contributed to the increased morbidity of fractures of lower end of femur.

The aims of our study are to

1) Compare functional outcome of patient with distal femur fractures treated by locking compression plate with that of supracondylar nail.
2) Analyse the importance of timing of surgery and its implications
3) Analyse the choice of implant for various Muller type 'C' factures.
4) Importance of biological / anatomical fixation and early mobilization
5) Union rate of fractures fixed with locking compression plate with that of supracondylar nail.

MATERIALS AND METHODS

This is prospective study of 20 cases of supracondylar fractures with intercondylar extension in adults treated by early surgical fixation with either locking condylar plate or supracondylar nail.

The period of surgery and follow up extends from July 2008 to September 2010.

It includes all grades of supracondylar fracture with intercondylar extension. Pathological fractures and fractures in children were excluded.

The time protocol extended from within 24 hours of injury to 14 days of injury.

Inclusion criteria's:

Age above 20 years

Compound fractures grade IIIA and less than grade IIIA

Supracondylar fractures with intercondylar extention

Exclusion Criteria's:

Age less than 20 years

Compound fractures more than grade IIIB

Co morbid ailments

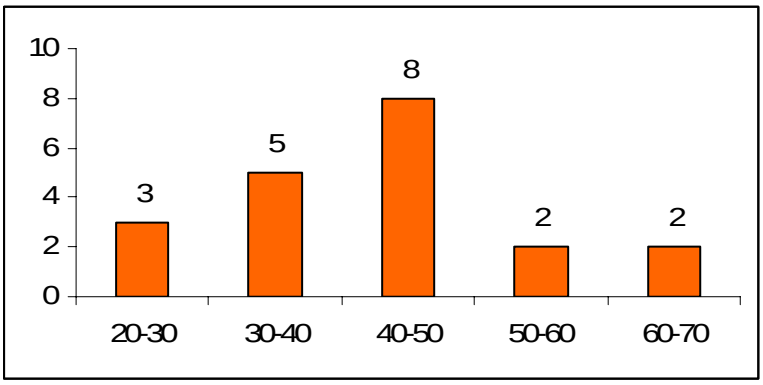
Pathological fractures

The cases were analysed as per the following criteria.

1. Age distribution
2. Sex distribution
3. Mode of injury
4. Duration between injury and hospitalization
5. Side of injury
6. Classification of fracture
7. Associated injuries
8. Time interval between injury and surgery
9. Implant used
10. Duration of stay post operatively

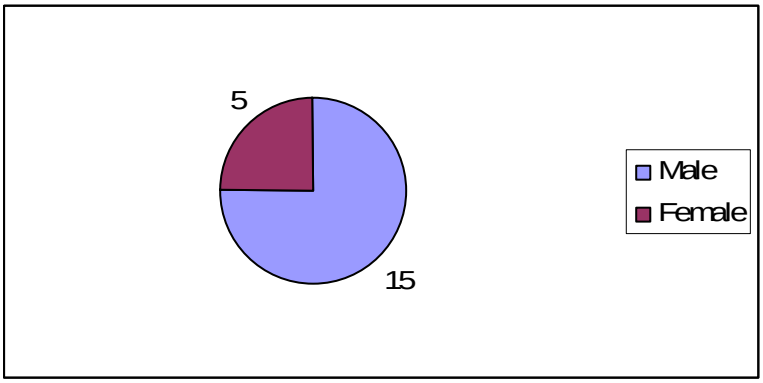
1. Age Distribution

The age group varied from 24 year to 70 years with the mean age of 45 years. The incidence of fracture was observed to be maximum between 30 to 50 years of age.



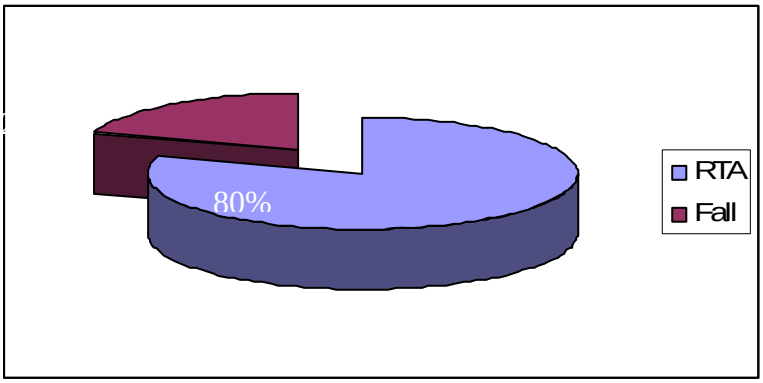
2. SEX DISTRIBUTION

The incidence was higher in males with 15 cases.



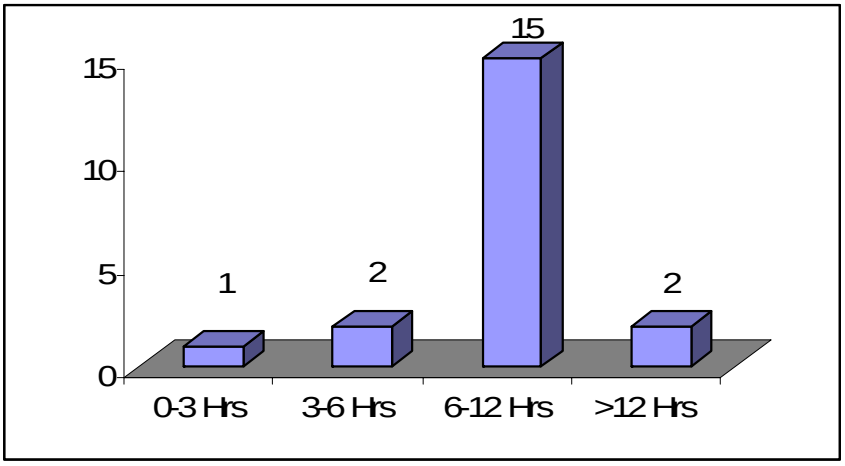
3. Mode of injury

The commonest mode of injury had been road traffic accident



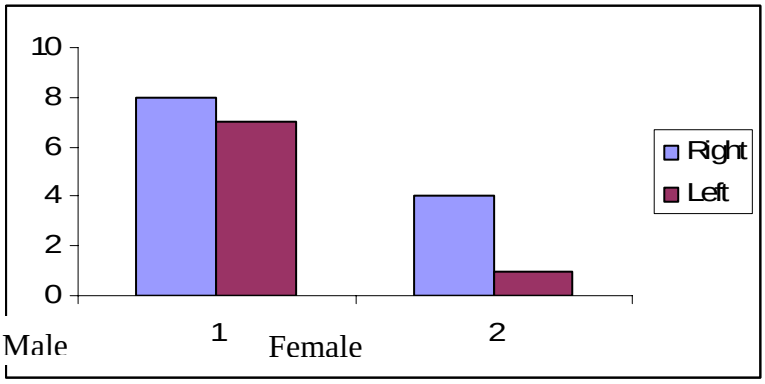
4. Duration between injury and hospitalization

Most of the injured patients were hospitalized within 12 hours.



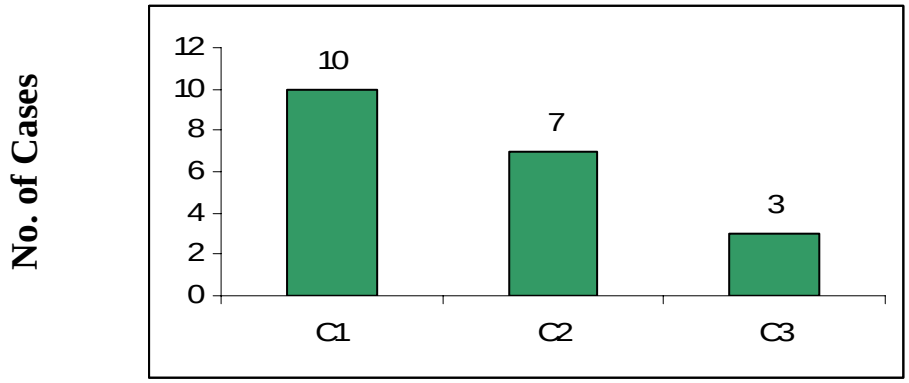
5. Side of injury

Right side was common in our series both in males and females.



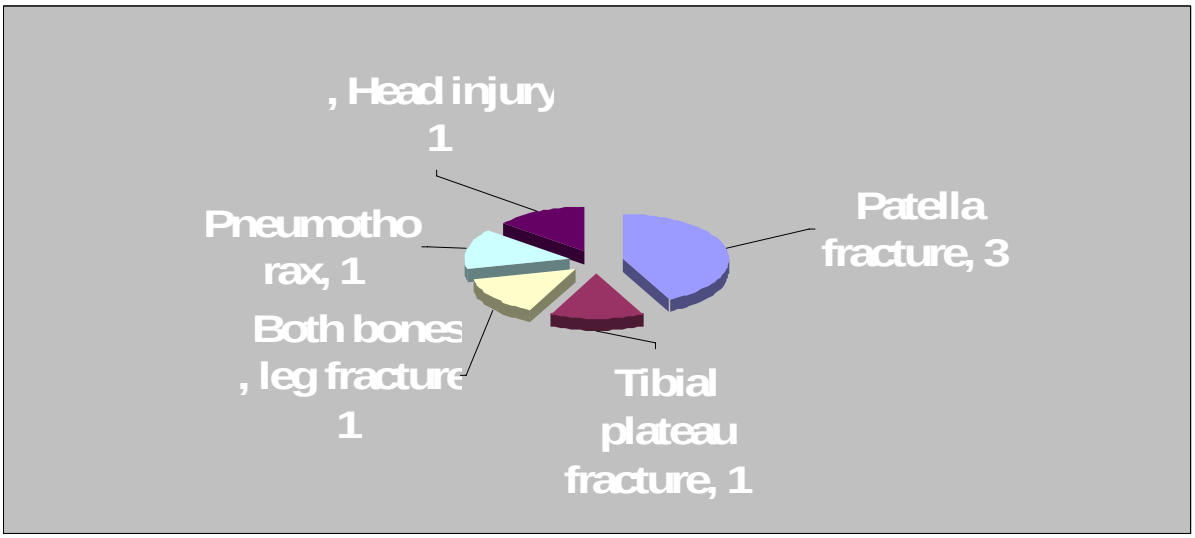
6. Classification of fracture

In our study Muller type C1 was most common amongst the intra articular fractures.

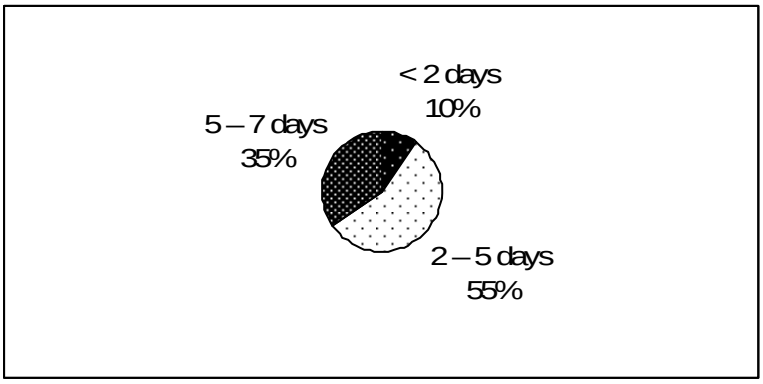


7. Associated injuries

Patella was the commonest associated structure that was fractured.



8. Time interval between injury and surgery



9. Implant used

Implant used	No. of cases
Locking compression plate	10
Supracondylar nail	10

10. Duration of stay post operatively

In our study the duration of post operative stay was much less in patients operated with closed intramedullary nail.

Procedure	Duration of stay
Plate osteosynthesis / Open intramedullary nail	12 days
Closed intramedullary nail	7 days

PROCEDURE AND POST OPERATIVE PROTOCOL

GENERAL MEASURES : All patient received in the emergency department were resuscitated for hypovolemia. If there was any other major associated injuries, they were treated accordingly first. After the general condition of the patient improved, radiographs (AP & lateral view) were taken. CT scan of the knee was taken in all patients.

All cases included in the study were intra articular fractures ie Muller type 'C'. They were fixed with either locking plate or supracondylar nail. Most of the cases were taken up for elective fixation before 5^{th} day. The patients who had associated injuries were taken up between 5^{th} and 7^{th} day. Tourniquet was not used in any of the cases as it restricted the field of procedure. Pre operative antibiotics were started two hours prior to surgery and was continued upto 10^{th} post operative day. In all cases spinal anesthesia was used. Primary bone grafting was used in cases in which open reduction was done and with metaphyseal comminution.

CLOSED REDUCTION AND INTERNAL FIXATION WITH SUPRACONDYLAR NAIL : The preoperative nail size and length were measured. The radiolucent table was used. We used supine position. A bolster was placed below the sterile drape under the thigh to flex the hip and knee. First the intercondylar fracture was reduced and temporarily stabilized with K-wire. The reduction was checked with image guidance and fixed with cannulated screws under image guidance. The screws were placed such that they provided maximum interfragmentary compression and were out of

the nails path. Mostly two screws were placed, one through the anterior part of the condyle and another through the posterior. The knee joint was opened by a patellar tendon splitting incision and the entry point of the nail and PCL were identified. The entry point is 0.5 cm anterior to the PCL attachments. It is enlarged with bone awl. Guide wire is passed. By manipulation and traction with image guidance the guide wire was negotiated into the proximal fragment. Reaming was done in 1mm increments. The nail with its jig was inserted and advanced over the guide wire. The nail was countersunk 1 – 2 mm below the articular surface. Two distal interlocking screws and two proximal locking screw were applied using the jig. Wound was closed in layers.

Open reduction and internal fixation with locking compression plate : We used both cobra locking plate and condylar buttress locking plate. Patient was placed supine on a radiolucent table with roll under the ipsilateral hip. We used the anterolateral approach with splitting of vastus lateralis. A lateral parapatellar arthrotomy with medial displacement of the patella provided adequate exposure of the intercondylar notch. The intercondylar fracture was reduced and fixed temporarily with K-wire. The locking plate was placed over the lateral condyle and held by K-wire. Then the metaphyseal fracture was reduced and held by reduction forceps. Later cannulated cancellous screws were inserted into the condyle over the K-wire and cortical screws were inserted into the metaphysis. The wound was closed in layers with a drain insitu.

POST OPERATIVE REHABILITATION

Post operative rehabilitation was decided by the stability of fracture. In type C1 & C2 ROM exercises along with quadriceps and hamstring exercises were started by second post operative day. The patients were allowed touch down weight bearing by the eighth day onwards. Most of the patients were allowed partial weight bearing with crutches from 6-8 weeks. Full weight bearing was allowed only after radiological evidence of union.

In patient with type C3 fractures quadriceps exercises and straight leg raising exercises were given for 3 weeks. After 3 weeks they were started on touch down weight bearing. Partial weight bearing was allowed after 10 – 12 weeks and full weight bearing was started only after radiological evidence of union.

The patients were followed up at 6 weeks, 12 weeks and 24 weeks. Regular X-rays were taken at each followup and the further course of rehabilitation decided. The functional outcome was rated using Neer's rating system at the end of six months. The results were graded as Excellent, Good, Fair and Failure.

PITFALLS AND THEIR MANAGEMENT

Infection :

Three cases developed wound infection, two of them were superficial stitch abscess and one was deep infection. The treatment protocol for superficial infection was continuation of antibiotics and daily dressing. Both healed without complication.

A case of deep infection was treated with thorough irrigation, excision of slough and debridement of infective material with continuation of antibiotics sensitive to the organism. Once the wound started granulating secondary suturing was done.

Knee stiffness

Knee stiffness occurred in two cases which were considered as poor results. Both of them were operated with supracondylar nail. The knee flexion in both the cases was less than 60 degrees. One of them was type C3 and the other had infection.

The causes of knee stiffness in these patients were multifactorial including infection, uncooperative patient, failure of proper follow up and fracture pattern. All the patients underwent one attempt of mobilization under anesthesia and were advised active assisted range of motion.

Malunion

Malunion occurred in one case. Since the patient was very old (65 years) and his functional disability was minimal with existing malunion and

his range of motion of knee joint was good, he was left without any intervention.

Delayed union

Delayed union occurred in two cases. It took five months for complete union in these two cases. Nothing except active physiotherapy was given.

Technical complications

Two early cases fixed with supracondylar nail required open reduction of fracture, this was mainly because of inexperience with the system.

Three cases of locking plate posed difficulty in maintaining the articular surface. Because they were of old age and the bone was severely osteoporotic, so it broke when reduction was attempted. Finally all were fixed with locking plate by removing the loose fragment and accepting the shortening that occurred out of it. It is always practical to keep the pin traction insitu, for proper traction during surgery.

Limb length inequality

Shortening of 1 – 2 cm occurred in three cases, none had any functional deficit.

RESULTS

Average time of healing of fractures was 14 weeks. In cases operated with supracondylar nail it was 16 weeks and in those with locking plate it was 12 weeks.

No fracture healed in more than eight degrees of varus or valgus malalignment. Two fractures healed in 5 to 10 degrees of recurvatum and none of these two had hyper extension. No fracture was fixed in more than 5 degree of flexion off normal alignment. No patient had an intraarticular step of more than 2 mm.

All patient were started on quadriceps and hamstring exercises on 2^{nd} postoperative day.

The average knee flexion in our series was 115^0 (ranging from 125^0 – 45^0). The knee flexion also varied with subtype of fracture and choice of implant. Shortening of 1 – 2 cm occurred in three cases.

Almost all patient remained painless during follow up except for 2 cases. In one case the nail protruded through the intercondylar notch and was removed. The other was in a patient treated with locking plate, where the cause of pain was unknown. It was of mild nature and patient was relieved of pain with analgesics and had good range of motion.

Functionally two patients used walking aid for a prolonged period (upto 16 months) all others discarded walking aid by 12 – 16 weeks.

ANALYSIS OF FUNCTIONAL OUTCOME

The rating system followed was that of Neer which takes into account pain, movement, function, shortening and angulation.

Overall results

Grading	No. of cases	Percentage
Excellent	13	65%
Good	3	15%
Fair	2	10%
Failure	2	10%

Results according to sub type

Subtype	Grading
C1	Excellent to Fair
C2	Excellent to Failure
C3	Excellent to Failure

RESULT ACCORDING TO THE IMPLANT USED

Implant	No. of cases	Grading	Percentage
Locking Plate	7	Excellent	70%
	2	Good	20%
	1	Fair	10%
	-	Failure	-
Supracondylar nail	6	Excellent	60%
	1	Good	10%
	1	Fair	10%
	2	Failure	20%

DISCUSSION

The aim of this study is to know the results of early surgical fixation of supracondylar fracture with intercondylar extension either with locking plate or supracondylar nail and to analyze the results.

Regardless of the type of implant used, when fracture was fixed well and followed up with proper physiotherapy and rehabilitation which may be more important than the surgery itself, the resultant range of motion at knee and hence the function is good.

We selected 20 cases of supracondylar fracture with intercondylar extension (Type C) of femur in adults. Of them three were compound fractures of different grades. The period of study was between June 2008 and September 2010. Most of the cases fell into middle age group of them 75% being male. All were due to high velocity injuries. The choice of implant was between locking compression plate and supracondylar nail. The decision of implant was based on its availability, age of patient, bone quality and associated injuries. William deLong and Frederick Bennet say, that supracondylar nail can be used for both Muller's type A & C.

The compound fractures were of grade I & II and hence were treated with initial wound wash and suturing followed by internal fixation on fifth day. Antibiotics were started preoperatively and were continued upto suture removal.

We preferred locking plate in Muller's type C3 over supracondylar nail. Giles , Sanders, Regazonni have reported better results with locking plates confirming our views. Geel and Ostrum suggested that locking plates were most suitable for patient with osteoporosis.

Supracondylar nail was associated with small incision, limited soft tissue damage and minimal blood loss. Gellman reported 12% cases of nail impingement in his series. Regazonni and Reudi have suggested that there is no increased complication due to locking plates in case of revision surgery, if needed. Our results are correlate well with similar series as that of Radford and Havell, Shewring and Meggit.

We preferred early fixation (within 14 days) of fracture lower end of femur because it gives a lot of advantages. First earlier surgery allows easy mobilization fracture fragments and easier reduction. Second it gives better results as far as knee joint mobilization by not allowing the quadriceps to go for wasting. Third it makes the patient ambulant at an early period. In addition Lawerence and Kenneth Johnson in their series on early versus delayed stabilization in polytrauma patient pointed out that earlier stabilization resulted in less or nil pulmonary complication, decreased hospital stay and minimal incidence of intensive care. They advocated that the incidence of ARDS, fat embolism & pneumonia were higher in multiple injuries patients, when stabilization of fracture was delayed. But they advised fixation within 24 hours. In our series we came across four

polytrauma cases, all of them were fixed with in 72 hours and none of them developed pulmonary complication correlating well with their series.

Preoperatively we followed certain meticulous techniques. Except in initial two cases, in all cases fixed with supracondylar nail, closed reduction was done. In the initial two cases we used femoral distractors to align the fragment and then opened the fracture site for reduction.

In all cases we used anterolateral approach by splitting vastus lateralis muscle. In all cases the incised muscle was carefully sutured with 1-0 vicryl with knots buried inside the substance of the muscle and the capsule was meticulously closed. M.S. Butt, Kirkler and Ali in their series on displaced fractures of distal femur in elderly patients advised meticulous closing of extensor apparatus for earlier postoperative rehabilitation.

Presence of other fractures had tremendous effects, on the functional outcome of our series. The worst being comminuted fracture of patella requiring patellectomy. We had two cases both of them produced only fair results because of the difficulties in rehabilitating the patient. One of our cases had PCL injury, but he did functionally very well without any surgical treatment for PCL injury. Reviewing the literature showed 2.3% incidence of vascular complications in these type of fractures. We did not encounter any.

We hesitate to use tourniquet as most of the cases required extensive skin incision. Michel Chapmen and Christopher Finkemcier also advocated avoiding tourniquet use.

We followed the rating system of Neer for function evaluation which gives equal importance to practical (pain, disability), clinical (shortening, knee flexion) and radiological (angulation) markers. We had 60% – 70% excellent results with this system, eventhough most series followed Neer system, some series like that of the Shewring and Meggitt followed other systems like Shatzker system. Good results have been reported after internal fixation by several authors like Schatzker, Giles, Mize, Bucholz, Grogan and Brooker. All have compared operative vs non operative management. We mainly pointed out the importance of early mobilization after early fixation in all cases and also showed that locking plate is the implant of choice in type C supracondylar fractures of femur.

CONCLUSION

THE CONCLUSIONS OF THIS STUDY ARE

- Supracondylar fractures of femur are more common in high velocity injuries like RTA and occurs in middle aged men
- Most fractures are Muller's type C1
- Early fixation of fracture followed by intense early and active post operative knee mobilization produces excellent results
- Locking compression plate is superior to all other devices for Muller's type C fractures
- Supracondylar nail can be used as an alternative in type C1 & C2
- Intramedullary fixation has following advantages
    - preservation of fracture hematoma
    - early mobilization
    - smaller incision
    - less blood loss
    - less intraoperative time
    - last but not the least; it is a load sharing device hence chances of implant failure are less

TO CONCLUDE

- Locking plate is the implant of choice for all type C supracondylar fractures
- Supracondylar nail provides a good alternative for type C1 & C2
- Early fixation of supracondylar fractures produces excellent functional results.

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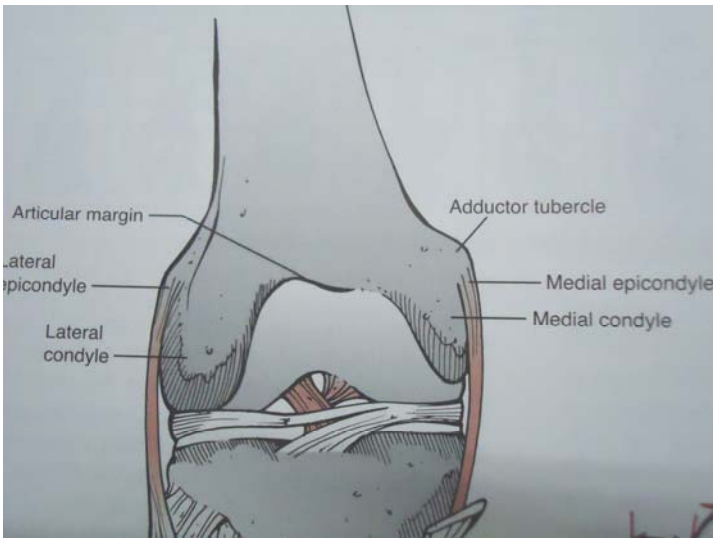
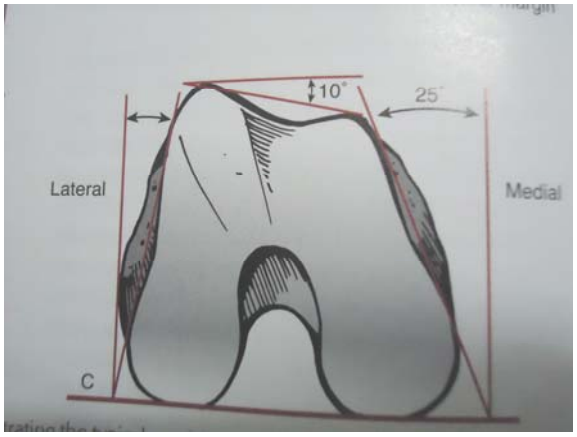
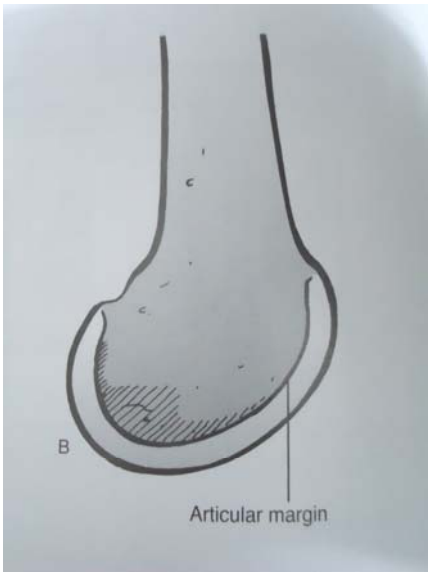
ANATOMY


Articular margin
Adductor tubercle
Medial epicondyle
Medial condyle
Lateral condyle


10°
25°
Lateral
Medial
C


B
Articular margin

AO CLASIFICATION

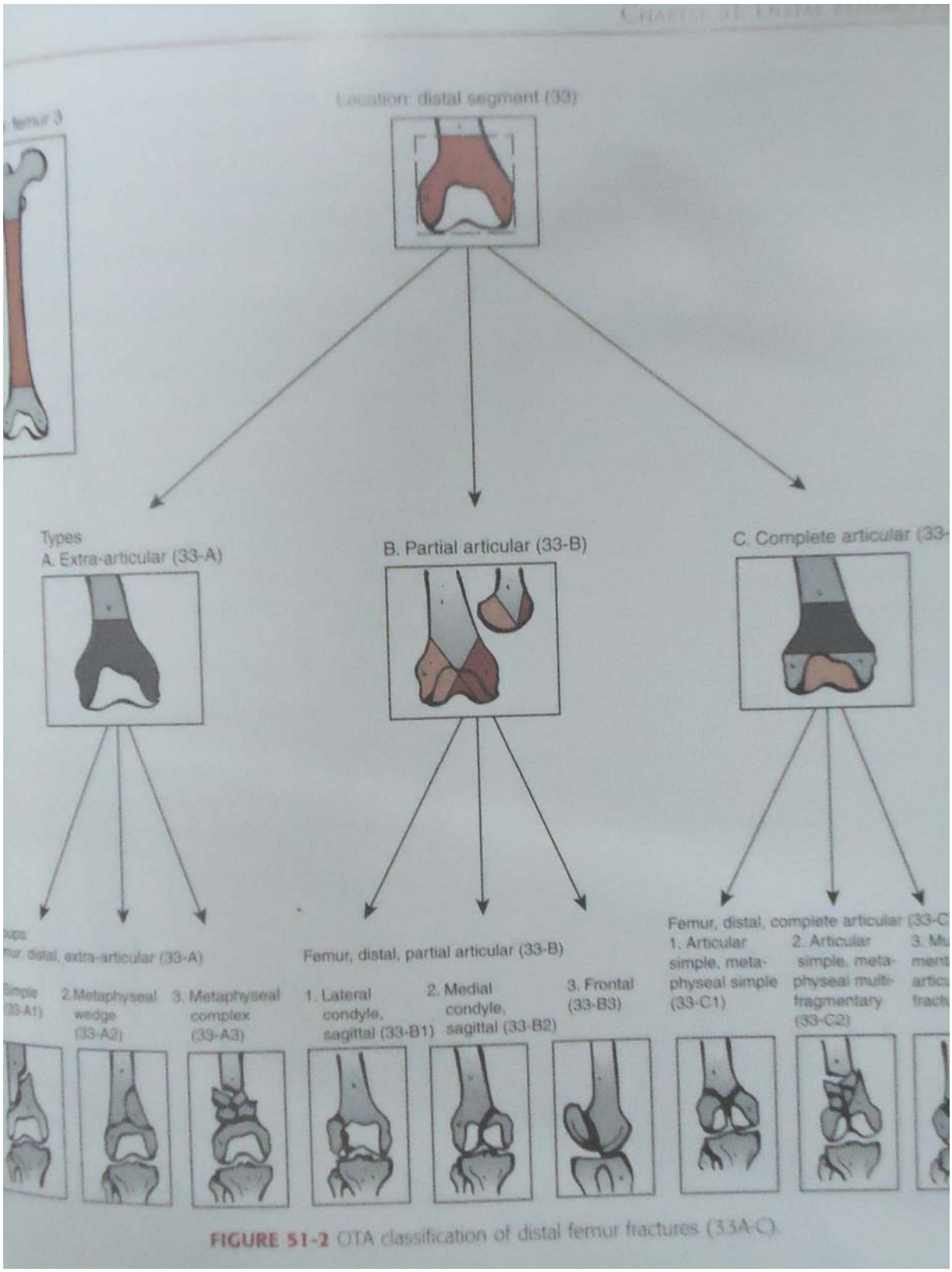
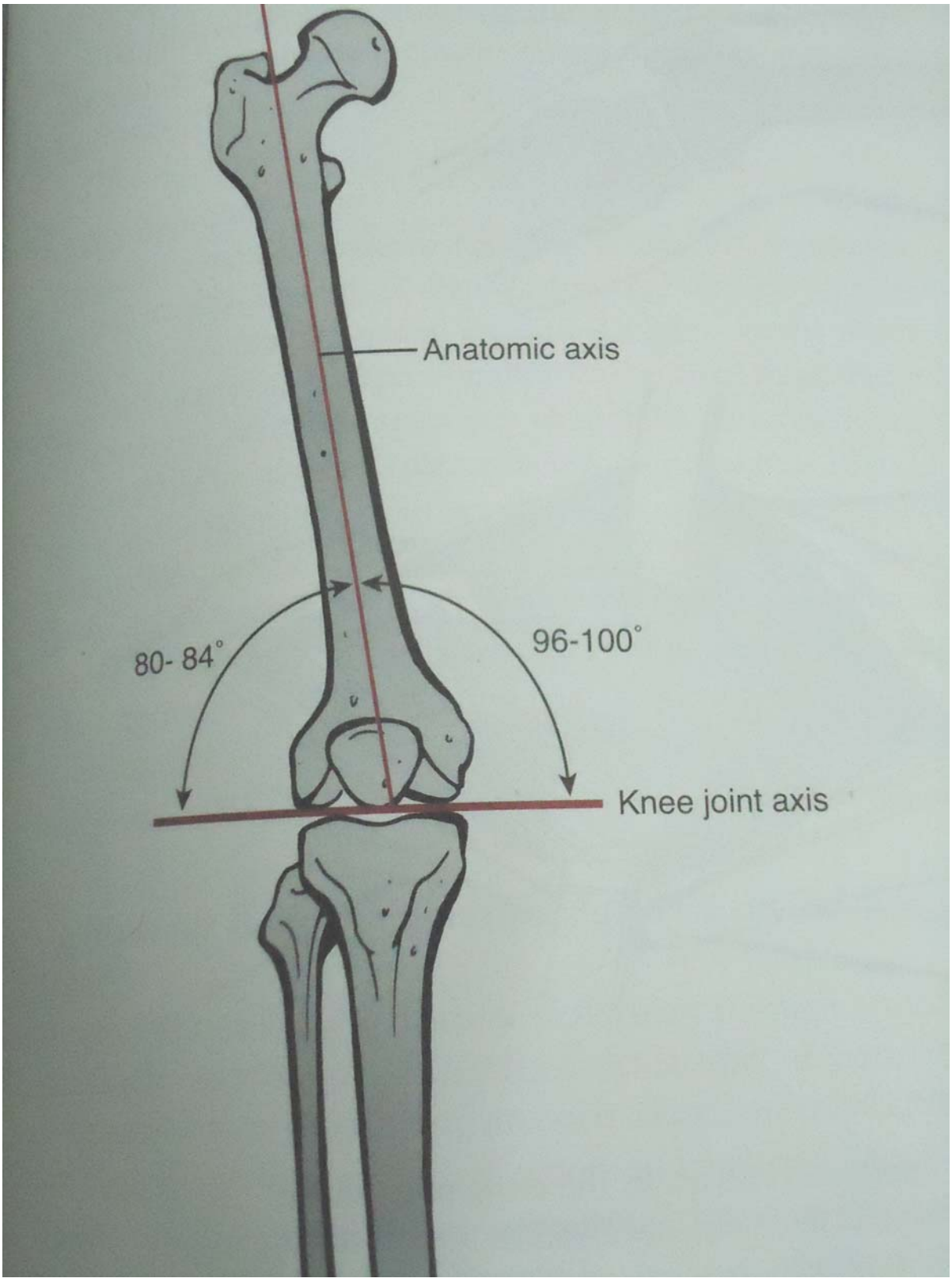


FIGURE 51-2 OTA classification of distal femur fractures (33A-C).

BIO MECHANICAL AXIS

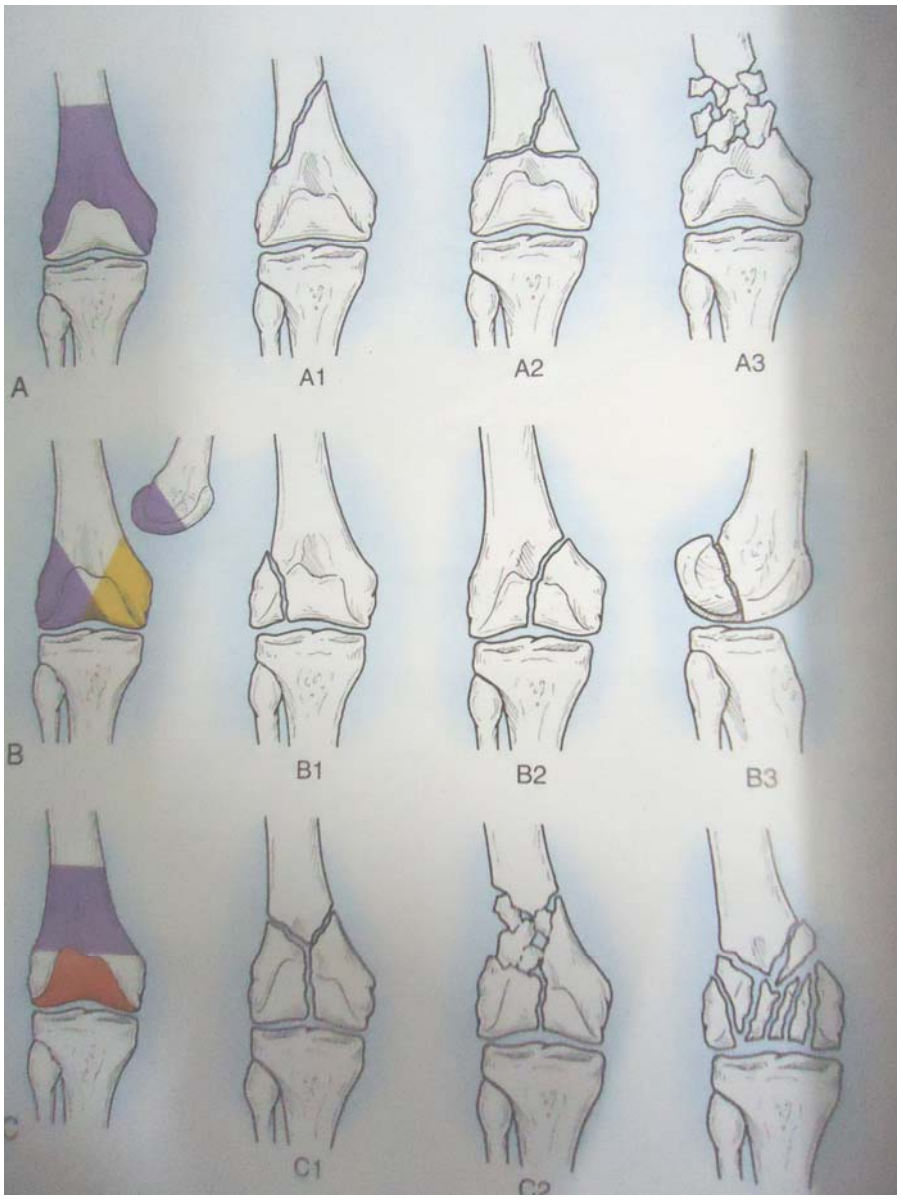


IMPLANTS

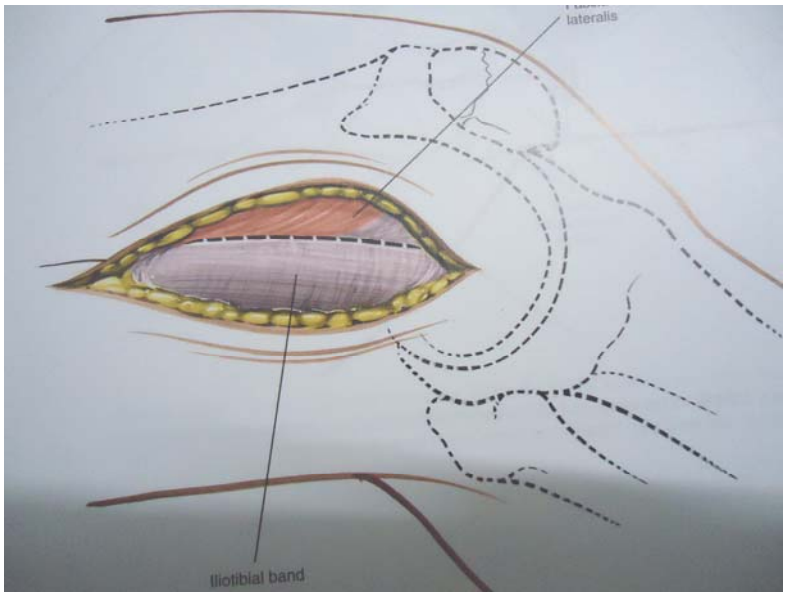
LOCKING PLATE

SUPRACONDYLAR NAIL

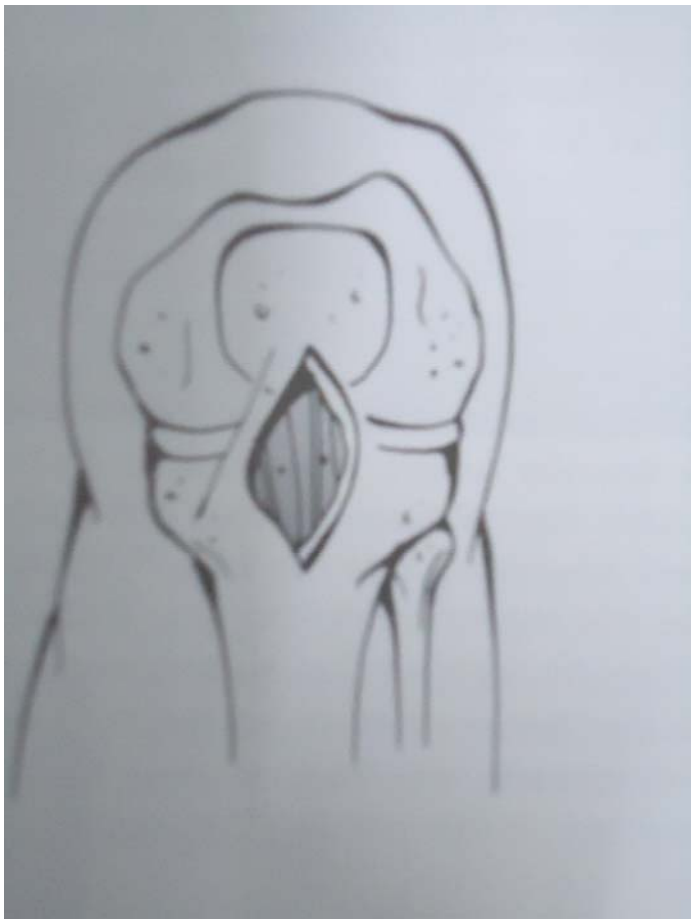
MULLER'S CLASSIFICATION



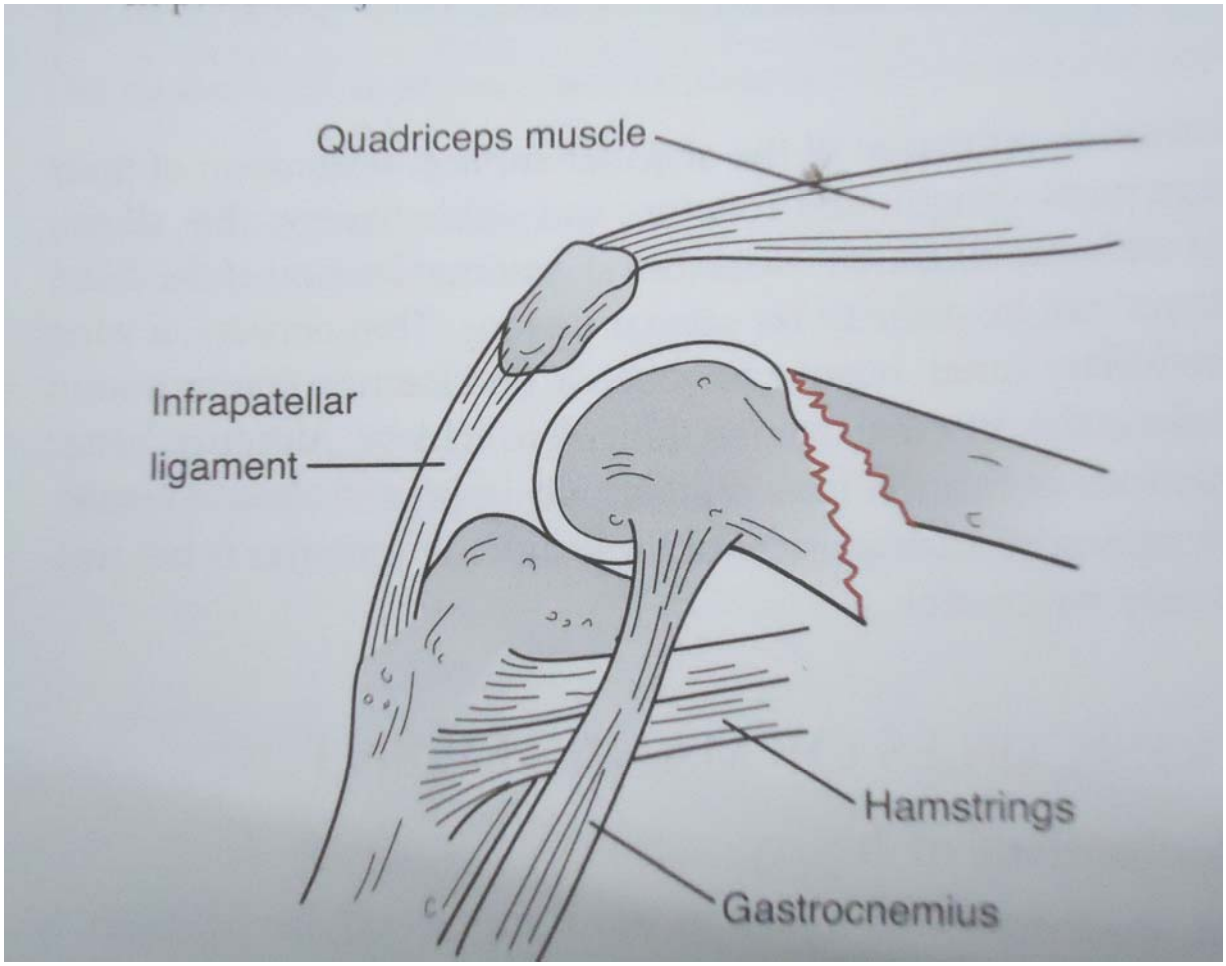
LATERAL APPROACH



APPROACH FOR SUPRACONDYLAR NAIL

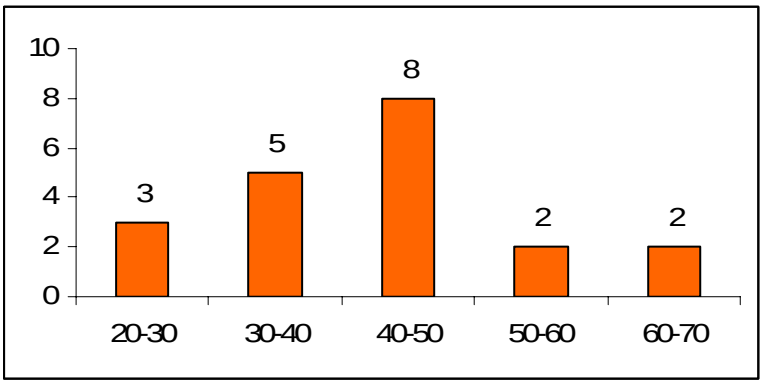


MECHANISM OF DISPLACEMENT



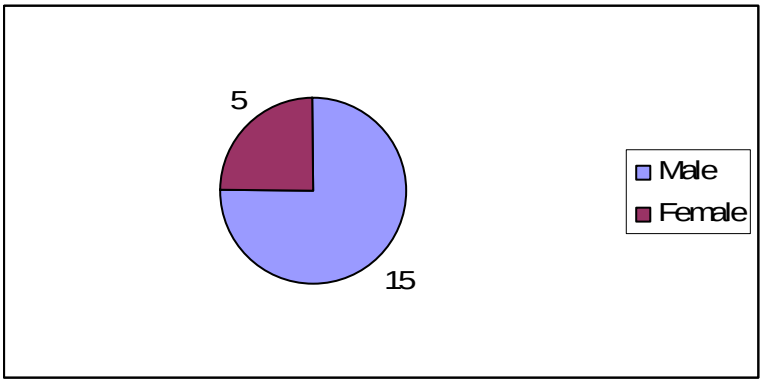
1. Age Distribution

The age group varied from 24 year to 70 years with the mean age of 45 years. The incidence of fracture was observed to be maximum between 30 to 50 years of age.



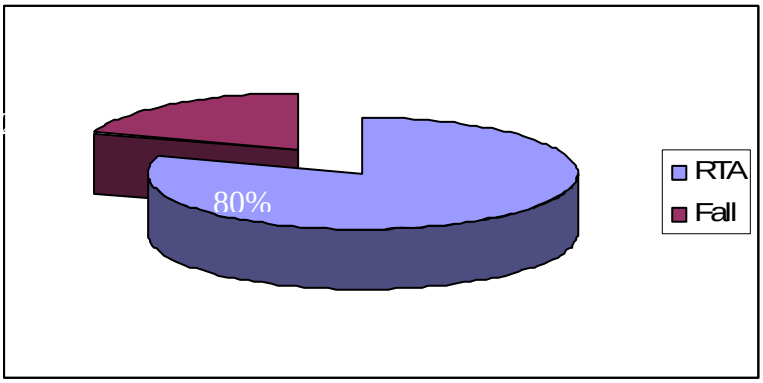
2. SEX DISTRIBUTION

The incidence was higher in males with 15 cases.



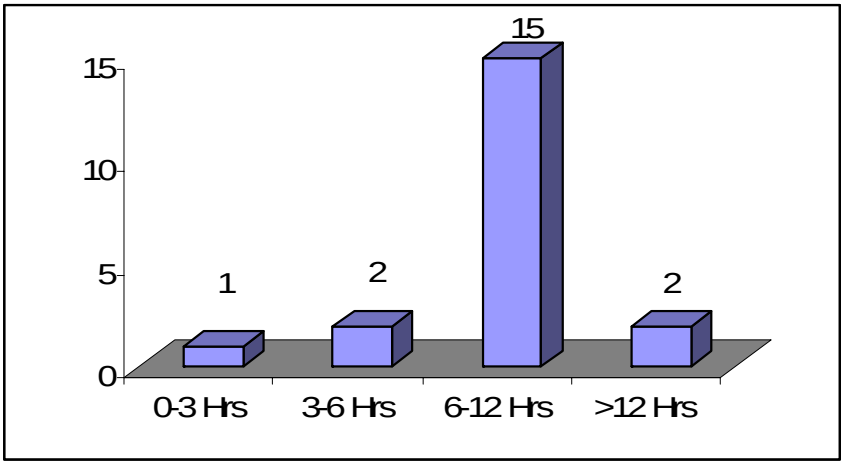
3. Mode of injury

The commonest mode of injury had been road traffic accident



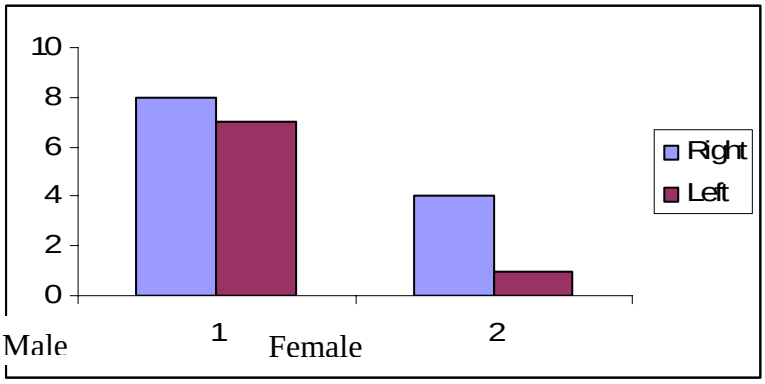
4. Duration between injury and hospitalization

Most of the injured patients were hospitalized within 12 hours.



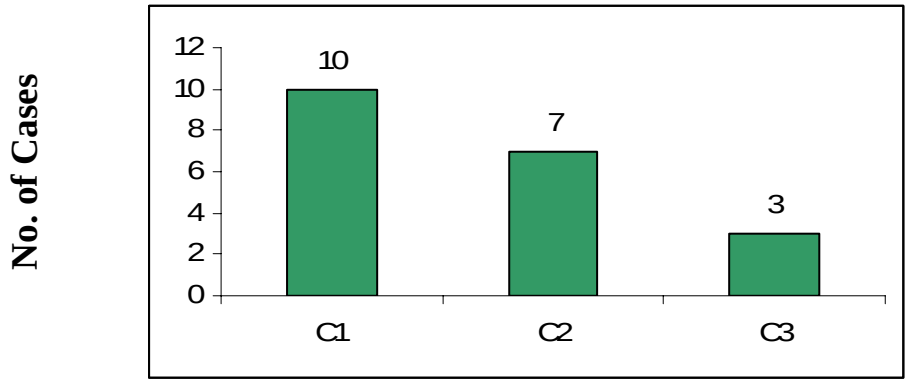
5. Side of injury

Right side was common in our series both in males and females.



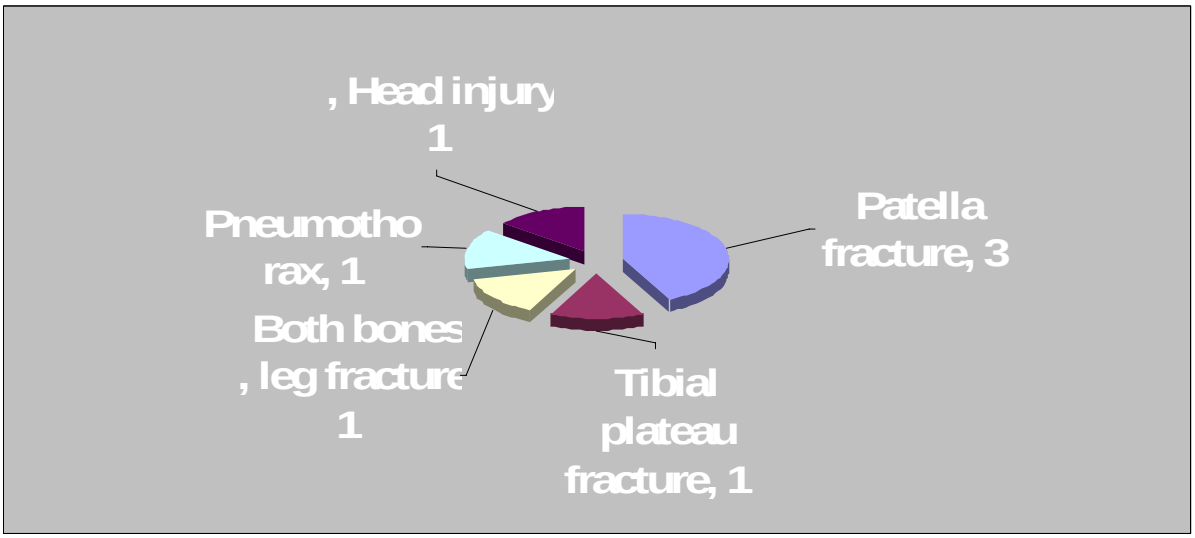
6. Classification of fracture

In our study Muller type C1 was most common amongst the intra articular fractures.



7. Associated injuries

Patella was the commonest associated structure that was fractured.



CASE 1

PRE OPERATIVE

POST OPERATIVE

3 MONTHS

CASE 2

PRE OPERATIVE

POST OPERATIVE

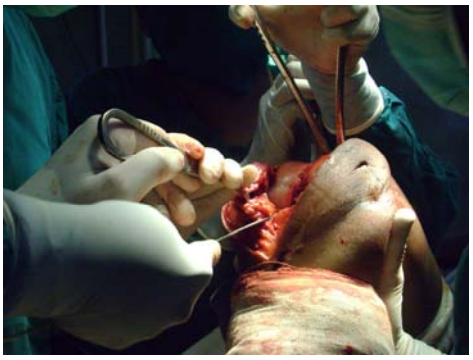
3 MONTHS

6 MONTHS

CASE 4

PRE OPERATIVE

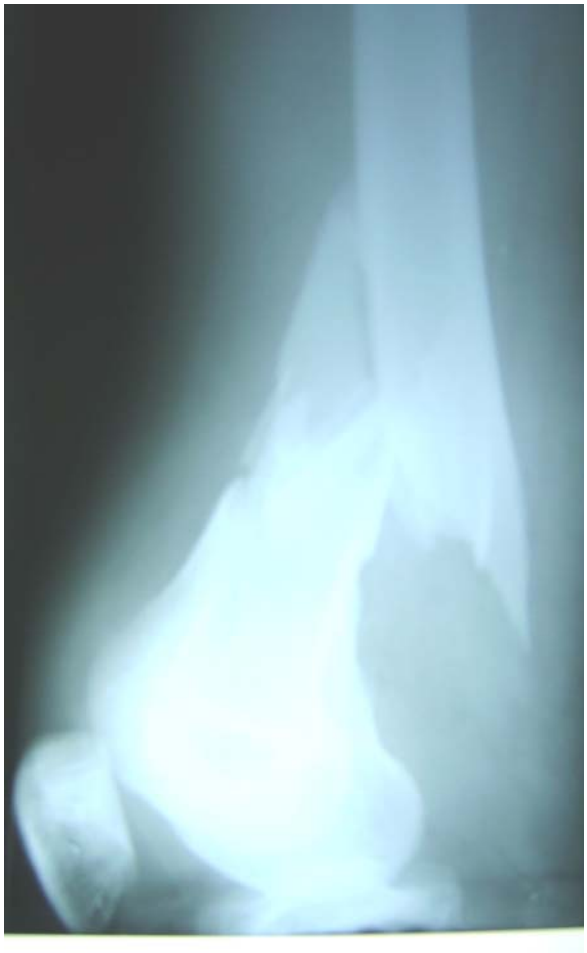
INTRA OPERATIVE



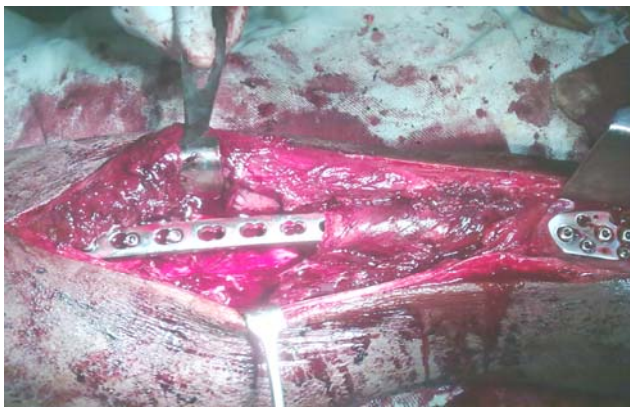
POST OPERATIVE

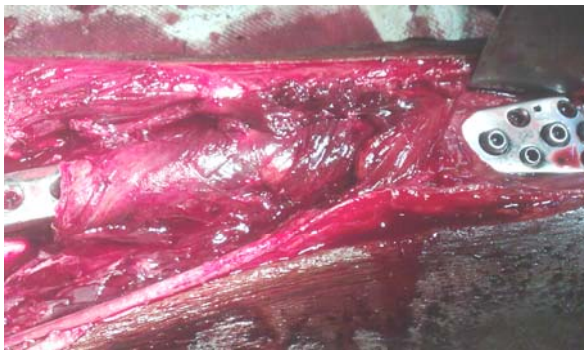
CASE 5

PRE OPERATIVE



INTRA OPERATIVE





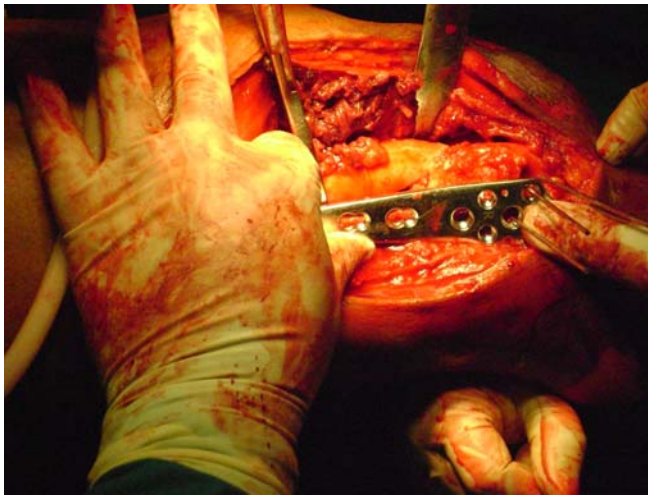
POST OPERATIVE

RANGE OF MOVEMENT

CASE 7

PRE OPERATIVE

INTRA OPERATIVE

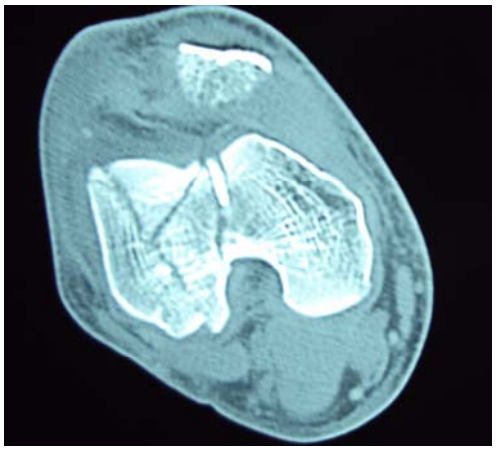


POST OPERATIVE

CASE 8

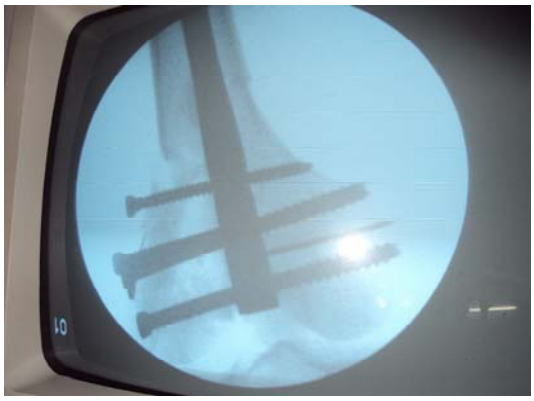
PRE OPERATIVE

CT IMAGE



INTRA OPERATIVE

C-ARM IMAGE



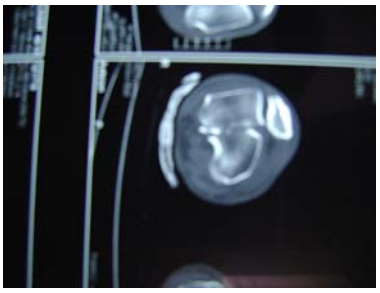
POST OPERATIVE

6 MONTHS

CASE 9

PRE OPERATIVE

PRE OPERATIVE CT



POST OPERATIVE

CASE 10

PRE OPERATIVE

POST OPERATIVE

3 MONTHS

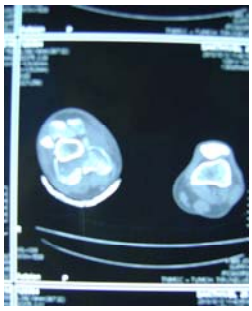
6 MONTHS

10 MONTHS

CASE 13

PRE OPERATIVE

PRE OPERATIVE CT



INTRA OPERATIVE

POST OPERATIVE

CASE 15

PRE OPERATIVE


POST OPERATIVE


EARLY MOBILIZATION

3 MONTHS


MASTER CHART

Sl. No	Age	Sex	Side	Mode of Injury	Type	Time of surgery (days)	Associated injuries	Treatment modality	Duration of surgery (hrs)	Blood transfusion	Union time	Return to work	ROM (degree)	Complications	Score
											Weeks				
1	28	M	R	RTA	C2	3	-	Locking Plate	2½	+	14	16	>120		20
2	34	M	L	RTA	C1	4	-	Locking Plate	2	+	13	16	120		19
3	47	M	R	Fall	C1	6	-	Nail	2	-	16	20	100		18
4	55	F	R	RTA	C3	3	-	Nail	2½	+	16	20	<60	Knee stiffness	6
5	24	M	R	RTA	C2	1	Patella fracture	Locking Plate	3	+	12	16	110	Superficial infection	18
6	42	M	L	RTA	C1	4	-	Locking Plate	2½	+	12	15	120		19
7	50	M	L	RTA	C2	5	Both bones leg fracture	Locking Plate	3½	+	13	16	90		14
8	30	M	R	RTA	C1	4	-	Nail	2	-	16	18	>120		20
9	49	F	L	RTA	C3	6	Pneumothorax	Locking Plate	3	+	14	16	100		16
10	36	M	R	RTA	C1	4	-	Nail	2	-	18	20	90		15

11	43	M	R	RTA	C1	1	Patella fracture	Nail	2	-	16	18	110	Superficial infection	19
12	65	F	R	Fall	C2	5	-	Nail	2	+	18	20	90	Malunion	12
13	38	M	L	RTA	C2	3	-	Locking Plate	2½	-	15	16	120		19
14	44	F	R	RTA	C1	3	-	Nail	2	-	20	24	90	Delayed union	10
15	35	M	R	RTA	C3	3	-	Locking Plate	3	+	12	16	120		20
16	70	M	L	FALL	C1	6	-	Locking Plate	2½	+	14	16	80	Deep infection	9
17	40	M	L	RTA	C2	4	Patella fracture	Nail	2½	+	14	16	>120		20
18	45	M	R	RTA	C1	5	Tibial Plateau fracture	Nail	3½	-	20	24	100	Delayed union	19
19	45	F	R	RTA	C1	3	-	Locking Plate	2½	+	14	16	110		20
20	58	M	L	Fall	C2	7	Head injury	Nail	2	-	12	16	<60	Knee stiffness, superficial infection	7